



**CALIFORNIA
ENERGY COMMISSION**



**CALIFORNIA
NATURAL
RESOURCES
AGENCY**

California Energy Commission
Clean Transportation Program

FINAL PROJECT REPORT

South Pasadena Hydrogen Station

Prepared for: California Energy Commission

Prepared by: FirstElement Fuel, Inc.

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California Energy Commission

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ACKNOWLEDGEMENTS

The construction of the South Pasadena hydrogen refueling station has only been possible because of the substantial efforts and funds provided by a number of stakeholders. FirstElement Fuel graciously thanks Toyota for their vision and fortitude, Air Products and Chemicals Inc., Black & Veatch, and Fastech for bringing the project together, Tyson Eckerle for helping push the lease over the goal line, and of course, Jean Baronas, Phil Cazal, Jim McKinney, Commissioner Janea Scott and many others at the California Energy Commission for tremendous, sustained confidence in clean, alternative transportation.

PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-607 to provide funding opportunities under the Clean Transportation Program for high performance hydrogen retail refueling stations. In response to PON-13-607, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards on May 1, 2014 and the agreement was executed as ARV-14-008 on July 22, 2014.

ABSTRACT

Per the terms of funding agreement ARV-14-008 between the California Energy Commission and FirstElement Fuel, Inc., FirstElement Fuel, Inc. designed, engineered, permitted, constructed, and commissioned a hydrogen refueling station located at 1200 Fair Oaks Avenue, South Pasadena, CA 91030. FirstElement Fuel, Inc. plans to own and operate the hydrogen refueling station until at least 2025. The station consists of a concrete reinforced block compound that encloses hydrogen storage, compression, and cooling equipment, a dispenser with two fueling hoses, a customer payment interface, a canopy, and a dedicated concrete fueling position for fuel cell vehicle drivers.

Keywords: California Energy Commission, FirstElement Fuel, Inc., hydrogen refueling station, hydrogen infrastructure, fuel cell vehicles, South Pasadena.

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EXECUTIVE SUMMARY

Hydrogen fuel cell electric vehicles and hydrogen refueling stations are expected to play key roles in California as the state transitions to lower-carbon and zero-emission vehicle technologies for light-duty passenger vehicles, transit buses, and truck transport fleets. Numerous government regulations and policy actions identify fuel cell electric vehicles as a vehicle technology that will be available to meet the California Air Resources Board Zero Emission Vehicle Regulation and the Governor's Zero Emission Vehicle Mandate. More specific actions to bring fuel cell electric vehicles to California markets are specified in the Governor's *Zero Emission Vehicle Action Plan*.

Hydrogen fuel cell electric drive technology offers tremendous potential for the light-duty passenger vehicle market and medium- and heavy-duty truck and bus markets. Fuel cell electric vehicle passenger vehicles can drive more than 300 miles on a tank of hydrogen and can be refueled in 3 to 4 minutes the way gasoline passenger vehicles are fueled. They have zero tailpipe emissions, while the carbon footprint of these vehicles is nearly the same as plug-in electric vehicles. The technology can be readily scaled up for SUVs, family passenger vans, pick-up trucks, urban package and beverage delivery trucks, and even heavy-duty trucks and buses. Most auto industry analysts and agencies view fuel cell electric drive technology as a complement to battery electric drive technologies, rather than as a competing technology. Both battery and fuel cell electric vehicle technologies will be needed in California to achieve the zero-emission vehicle deployment goals.

In contrast to battery electric and plug-in hybrid electric vehicles that can be charged in home settings, fuel cell electric vehicles require a new network of refueling stations that dispense pressurized hydrogen for consumer use. This has meant that the auto industry and station development industry have had to co-develop two new technologies in parallel: hydrogen refueling infrastructure and hydrogen fuel cell electric vehicles. Fuel cell electric vehicles cannot be widely marketed and sold to consumers without a minimum network of refueling stations available.

Assembly Bill 8 (AB 8, Perea, Chapter 401, Statutes of 2013) reauthorized the original Assembly Bill 118 funding program (Núñez, Chapter 750, Statutes of 2007) and created new legal requirements for the California Energy Commission's Clean Transportation Program. The bill directs the California Energy Commission to allocate up to \$20 million per year, or up to 20 percent of each fiscal year's available funding, for the development of hydrogen refueling stations "until there are at least 100 publicly available hydrogen-fueling stations in operation in California" (Health and Safety Code 43018.9[e][1]).

The California Energy Commission contributed \$1,451,000 of the total \$2,388,101 cost to design, engineer, permit, construct, and commission the station.

The Site selected for this project was 1200 Fair Oaks Avenue, South Pasadena, California. A hydrogen refueling station at this location will serve as a core station in southern California for at least the next 10 years. FirstElement Fuel, Inc. accomplished this goal through the steps outlined below.

The owner at South Pasadena was excited to bring a clean, alternative fuel to his station. Lease terms were negotiated, and a lease was executed between FirstElement Fuel, Inc. and the South Pasadena owner on December 31, 2014.

The site configuration and design were developed by FirstElement Fuel, Inc. and detailed engineering design was performed by Black & Veatch. The zoning process in South Pasadena was frustrated by pre-existing conflicts between the gasoline station owner and neighboring property owners. Three zoning commission hearings, a City Council hearing, and legal action against the City of South Pasadena were all navigated to finally garner zoning approval on March 16, 2016.

Permits for zoning, building, mechanical, electrical, plumbing, and fire were finalized on August 26, 2016.

Hydrogen refueling station equipment was purchased from Air Products and Chemicals and the remainder of materials were sourced from a variety of general and specialty vendors. Fastech from Buena Park, CA was selected as the contractor for the project because of their relatively low bid, excellent safety record, and good standing with Black & Veatch. Construction began on October 24, 2016 and was complete on February 1, 2017.

Commissioning began on February 1, 2017 and was complete on February 22, 2017. The FirstElement team performed the bulk of the commissioning tasks including cleaning, purging, and pressure testing with Air Products performing final start-up.

CHAPTER 1:

Station Design and Construction

Project Timeline

There were many steps required to bring the South Pasadena hydrogen refueling station project to completion. The following synopsis highlights the most critical items, provides detail on each one, and states the timing required for each step for this particular project.

Site Acquisition (Fall 2013 – 12/31/2014)

Beginning in the Fall of 2013, First Element Fuel, Inc. (FE) took steps to identify and acquire appropriate sites for the station. FE worked with historic vehicle sales data, academic publications, automakers, and the CEC's Station Location Areas to select desired market locations. FE then analyzed specific properties within the target locations to find sites that could meet the space requirements for hydrogen fueling equipment.

After selecting general locations and specific sites, FE contacted station owners and operators to negotiate lease opportunities. A Letter of Intent was executed with the property owner at 1200 Fair Oaks Avenue, South Pasadena, CA 91030 on January 27, 2014. A binding 10-year lease was later executed on December 31, 2014.

Equipment Procurement (September 16, 2014 – January 17, 2017)

FirstElement selected Air Products equipment because of the cost, capacity, reliability, and more mature supply chain as compared to other suppliers as detail in the FirstElement PON application. A contract was executed with Air Products for the equipment on September 16, 2014 and equipment was delivered to the site on January 17, 2017.

Site Design and Engineering (7/22/2014 – 9/21/2016)

FE and Black & Veatch conducted a preliminary site survey to begin the site layout process on July 22, 2014. Initial engineering drawings were generated on September 24, 2014. These construction drawings (CD) are referred to as "CD30s" because they represent 30 percent complete construction drawings and contain only 2 pages. Figure 1 shows the equipment compound drawing from the CD30 drawing set. As shown, the drawing lacks specific detail and serves only to outline the site plan.

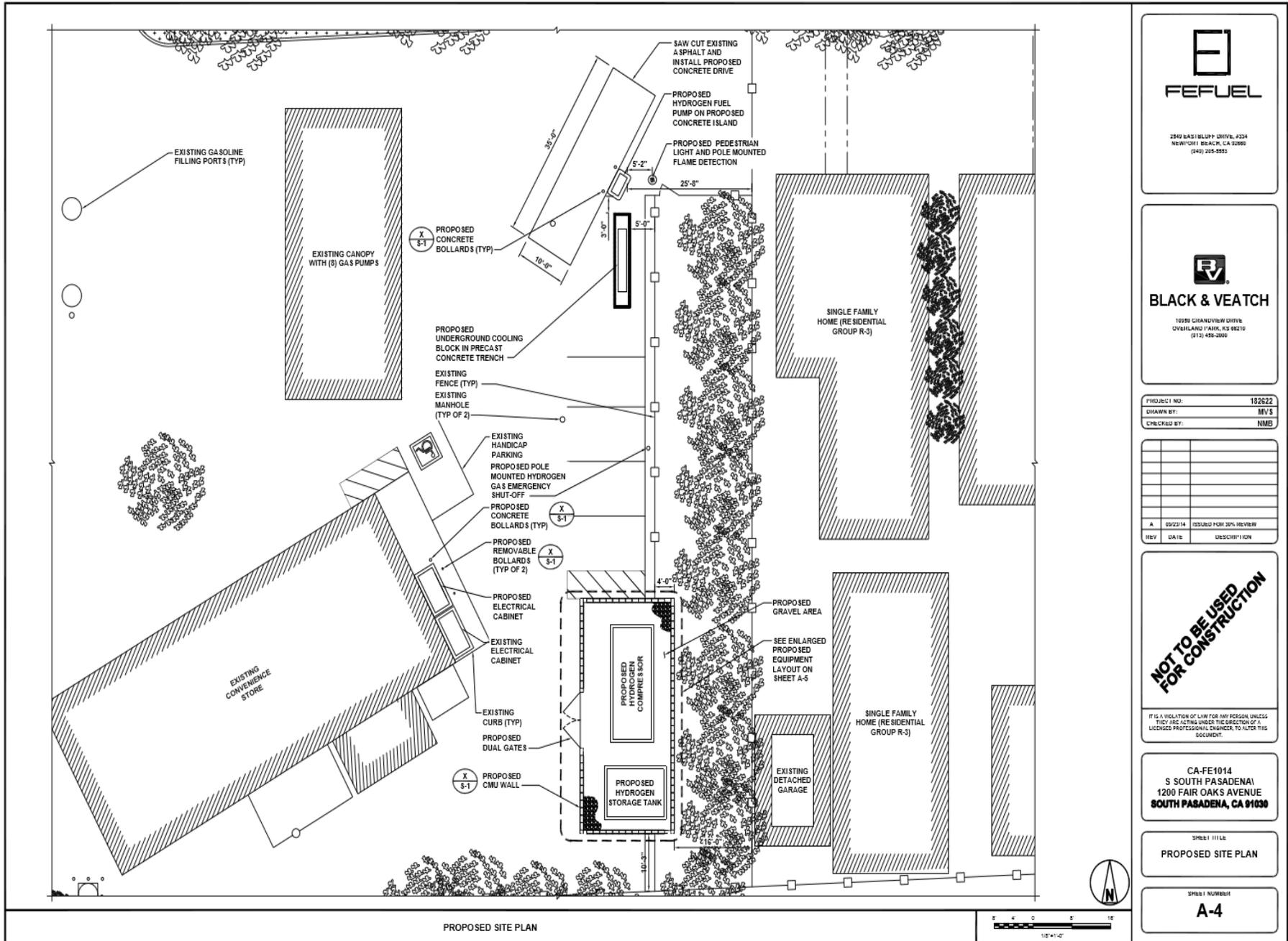
On October 14, 2014, a detailed engineering survey for the South Pasadena station site was subsequently performed by Clark Survey as shown in Figure 2.

On November 25, 2014, zoning drawings were also generated that provide an accurate but relatively high-level depiction of the project for review by planners at the jurisdiction. These drawings are signed and sealed by the professional engineer of record to ensure their accuracy and completeness. The equipment compound page of the zoning drawings is shown in Figure 3.

On June 15, 2015, draft final construction drawings (or "CD 90s") were completed that depict all of the minute detailed required for both construction and the permit review process. Final construction drawings (or "CD 100s") were completed with 60 pages that depict all of the minute detailed required for both construction and the permit review process on September 21, 2016. These drawings are similarly signed and sealed by the professional engineer of

record to ensure their accuracy and completeness. The equipment compound page of the CD100 Drawings is shown in Figure 4.

Figure 1: Relatively Coarse Detail of Equipment Compound from CD30 Drawing



FEFUEL

2342 EAST BILLYP DRIVE, #204
NEWPORT BEACH, CA 92660
(949) 265-0553

BLACK & VEATCH

10950 GRANDVIEW DRIVE
OVERLAND PARK, KS 66210
(913) 450-2000

PROJECT NO:	182622
DRAWN BY:	MV/S
CHECKED BY:	NMB

REV	DATE	DESCRIPTION
A	05/23/14	ISSUED FOR 20% REVIEW

NOT TO BE USED FOR CONSTRUCTION

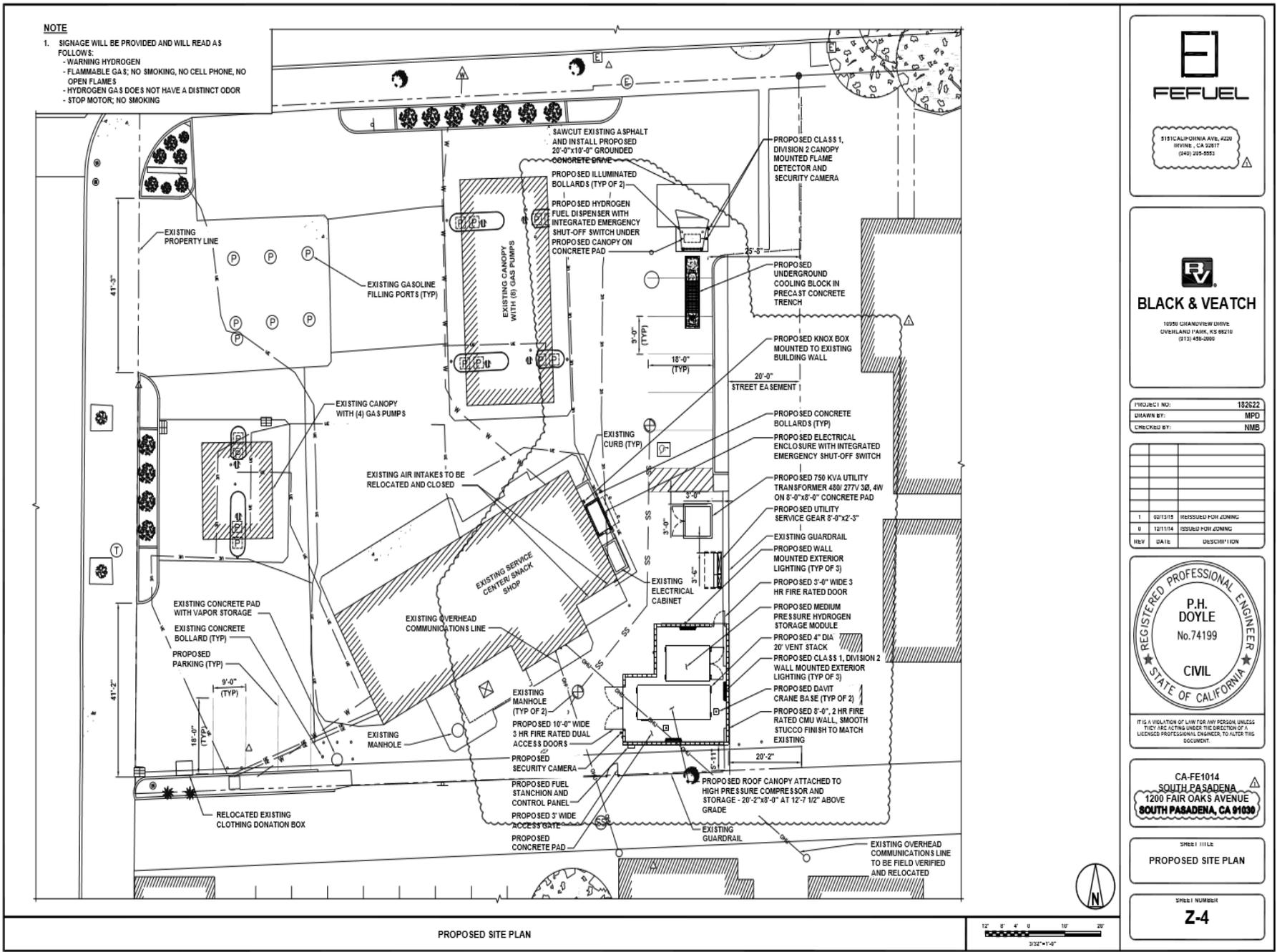
IT IS A VIOLATION OF LAW FOR ANY PERSON UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

CA-FE1014
S SOUTH PASADENA
1200 FAIR OAKS AVENUE
SOUTH PASADENA, CA 91030

SHEET TITLE
PROPOSED SITE PLAN

SHEET NUMBER
A-4

Figure 3: Detail of Equipment Compound from Zoning Drawing Set Showing More Detail and Accuracy than CD30



FEFUEL

311 CALIFORNIA AVE, #221
 IRVINE, CA 92617
 (949) 215-5553

BLACK & VEATCH

10950 GRANDVIEW DRIVE
 OVERLAND PARK, KS 66210
 (316) 435-2000

PROJECT NO: 192622
 DRAWN BY: MPD
 CHECKED BY: NMS

REV	DATE	DESCRIPTION
1	02/15/19	ISSUED FOR BIDDING
2	12/11/14	ISSUED FOR BIDDING

REGISTERED PROFESSIONAL ENGINEER
 P.H. DOYLE
 No. 74199
 CIVIL
 STATE OF CALIFORNIA

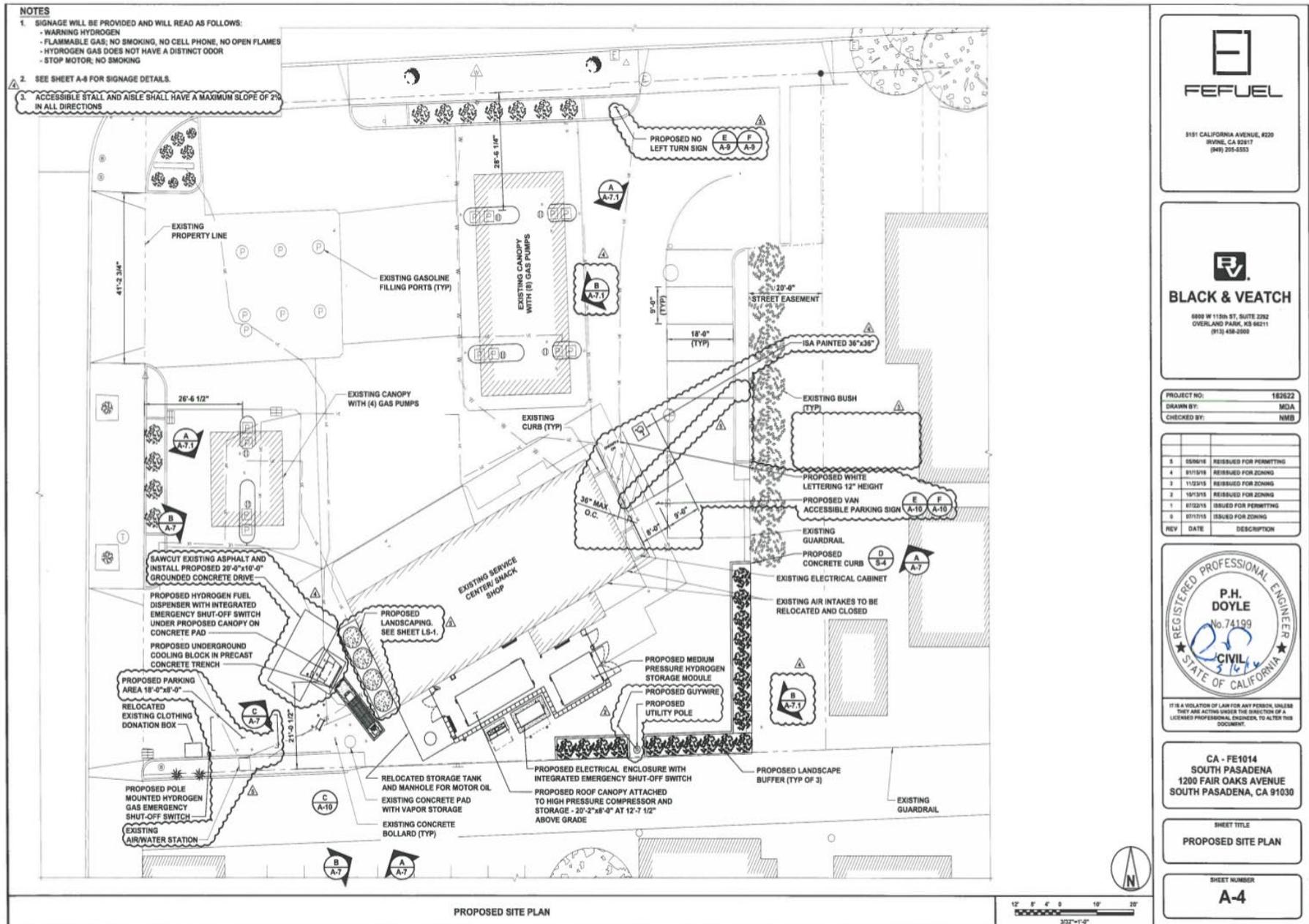
IT IS A VIOLATION OF LAW FOR ANY PERSON UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER TO ALTER THIS DOCUMENT.

CA-FE1014
 SOUTH PASADENA
 1200 FAIR OAKS AVENUE
 SOUTH PASADENA, CA 91030

SHEET TITLE
PROPOSED SITE PLAN

SHEET NUMBER
Z-4

Figure 4: Detail of Equipment Compound from CD100 Drawing Set Showing Complete Detail for Permitting and Construction



FEFUEL

3151 CALIFORNIA AVENUE, #220
IRVINE, CA 92617
(949) 255-6553

BLACK & VEATCH

8800 W 113th ST, SUITE 2302
OVERLAND PARK, KS 66211
(913) 438-2800

PROJECT NO: 162622
DRAWN BY: MDA
CHECKED BY: NMB

REV	DATE	DESCRIPTION
3	05/06/18	ISSUED FOR PERMITTING
4	01/15/18	ISSUED FOR ZONING
2	11/23/15	ISSUED FOR ZONING
2	10/13/15	ISSUED FOR ZONING
1	07/22/15	ISSUED FOR PERMITTING
0	07/17/15	ISSUED FOR ZONING

REGISTERED PROFESSIONAL ENGINEER
P.H. DOYLE
No. 74199
CIVIL
STATE OF CALIFORNIA

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTIVE UNDER THE SUPERVISION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT.

CA - FE1014
SOUTH PASADENA
1200 FAIR OAKS AVENUE
SOUTH PASADENA, CA 91030

SHEET TITLE
PROPOSED SITE PLAN

SHEET NUMBER
A-4

Entitlement Process (12/17/2014 – 3/16/2016)

The zoning application was submitted to the appropriate jurisdiction on December 17, 2014. The local planning department must verify that the project meets the zoning requirements of the proposed location, and approve any aesthetic, landscaping or other details that are important to the community. Approval was received at a City Council meeting on March 16, 2016.

Permit Process (7/24/2015 – 8/26/2016)

All building permit applications were submitted on July 24, 2015 and approved on August 26, 2016.

Construction Process (10/24/2016 – 2/1/2017)

FE and Black & Veatch submitted a detailed bid package to contractors on September 5, 2016. The contract was awarded to Fastech on September 26, 2015. The bulk of Fastech's experience lies in gasoline station construction and maintenance. Fastech has also built a number of hydrogen stations for other operators. Fastech provided a reasonable bid, had experience with hydrogen projects, and had a capability in southern California. Construction started October 24, 2016. Figure 5 shows the paving that was required for the station. Hydrogen storage, compression, cooling, and dispensing equipment was delivered to the site on January 17, 2017, as shown in Figure 6. Construction was completed on February 1, 2017.

Figure 5: Paving Operations in South Pasadena



Source: FirstElement Fuel, Inc.

Figure 6: Crane Lifting Hydrogen Compressor Unit Off of Delivery Truck in South Pasadena



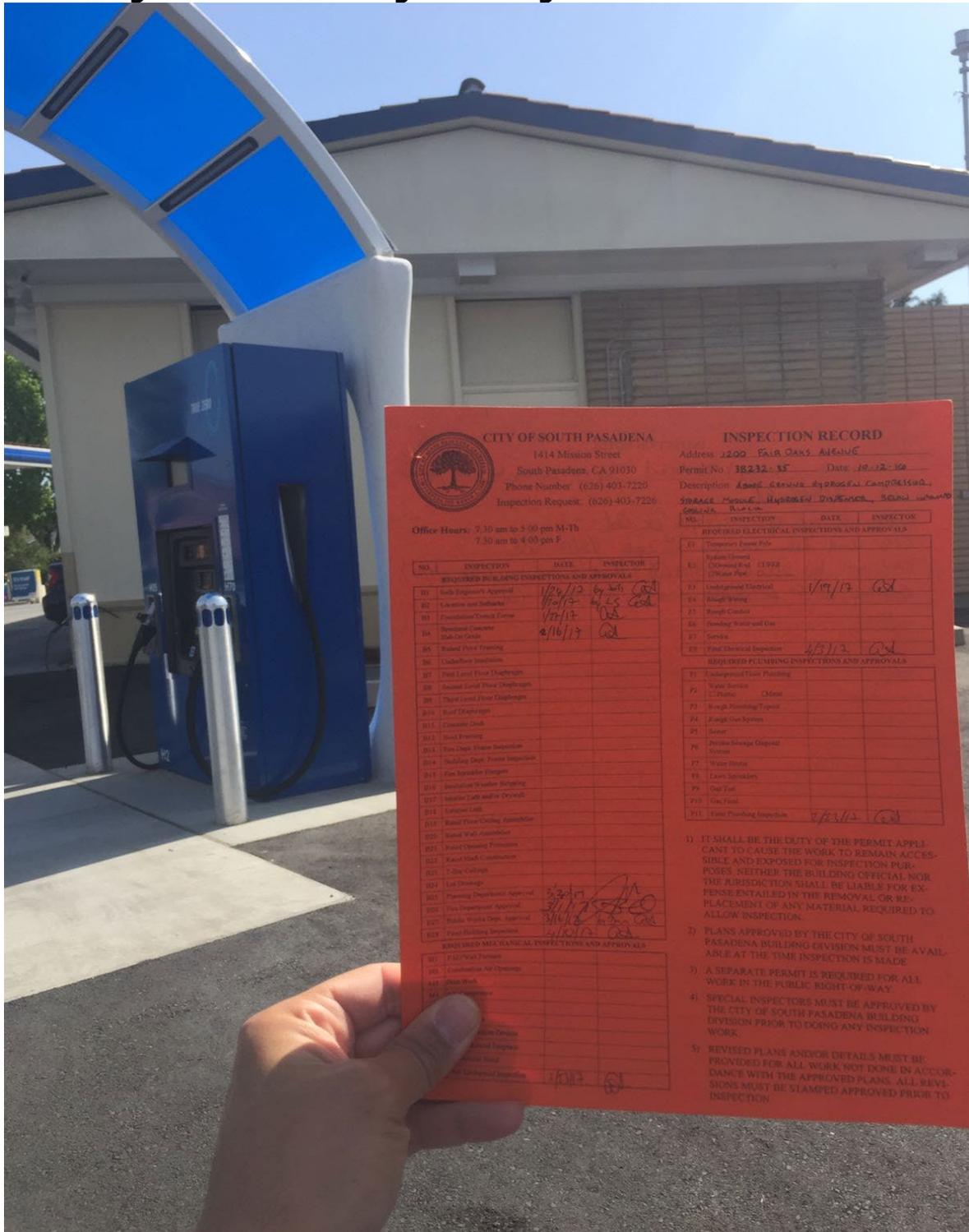
Source: FirstElement Fuel, Inc.

Commissioning Process (2/1/2017 – 2/22/2017)

Station Declared Operational (3/1/2017)

The South Pasadena hydrogen station met the CEC's definition of operational by completing installation of all station/dispenser components, obtaining all of the required permits from the local jurisdiction, filling the station's storage tubes with pressurized hydrogen gas, successfully passing a hydrogen quality test, successfully fueled one fuel cell vehicle with hydrogen, and becoming open to the public.

Figure 7: Final Building Permit Sign-off at South Pasadena



Source: FirstElement Fuel, Inc.

Figure 8: Hydrogen Fuel Quality Report on February 20, 2017

First Element Fuel South Pasadena Hydrogen Station

SAE J2719 : PASS	SAE J2719 Limits - $\mu\text{mol/mol}$	Smart Chemistry Detection Limits - $\mu\text{mol/mol}$	H70 H2 @Nozzle sampled on 2/20/2017 13:45:00 PM Concentration ($\mu\text{mol/mol}$)
H₂O (SAE J2719)	5	0.5	1.5
Methane (THC may exceed 2 micromoles per mole due only to the presence of methane, in which case the summation of methane, nitrogen and argon is not to exceed 100 ppm.)		0.001	3.8
Total Hydrocarbons (C, Basis), excluding Methane (SAE J2719)	2		0.46
Acetone			0.018
Acetylene/Ethene/Ethane			0.098
Ethanol			0.0078
Isopropyl Alcohol			0.003
Propane			0.11
Isobutane			0.15
n-Butane			0.03
2-Methyl-2-Propanol			0.048
O₂ (SAE J2719)	5	1	2.3
He (SAE J2719)	300	10	33
N₂ & Ar (SAE J2719)	100		
N₂		2	< 2
Ar		0.4	2.9
CO₂ (SAE J2719)	2	0.1	< 0.1
CO (SAE J2719)	0.2	0.0003	0.0011
Total S (SAE J2719)	0.004		0.000089
Hydrogen Sulfide		0.000002	0.00007
Carbonyl Sulfide		0.000002	0.000016
Methyl Mercaptan (MTM)		0.00001	< 0.00001
Ethyl Mercaptan (ETM)		0.00001	< 0.00001
Dimethyl Sulfide (DMS)		0.00001	< 0.00001
Carbon Disulfide		0.000002	0.0000026
Isopropyl Mercaptan (IPM)		0.00001	< 0.00001
Tert-Butyl Mercaptan (TBM)		0.00001	< 0.00001
n-Propyl Mercaptan		0.00001	< 0.00001
n-Butyl Mercaptan		0.00001	< 0.00001
Dimethyl Disulfide (DMDS)		0.00001	< 0.00001
Tetrahydrothiophene (THT)		0.00001	< 0.00001
Formaldehyde (SAE J2719)	0.01	0.001	< 0.001
Formic Acid (SAE J2719)	0.2	0.0005	< 0.0005
Ammonia (SAE J2719)	0.1	0.01	< 0.01
Total Halogenates	0.05		< 0.001
Cl₂ (SAE J2719)		0.00002	< 0.00002
HCl (SAE J2719)		0.00002	< 0.00002
HBr (SAE J2719)		0.00002	< 0.00002
Total Organic Halides (32 compounds in red and bold listed in "Non-Methane Hydrocarbons") (SAE J2719)		0.001 (Smart Chemistry limit is for each individual organic halide compound)	< 0.001
Particulate Concentration (SAE J2719)	1 mg/kg		0.15 mg/kg
Particulates Found & Size (SAE J2719)			There are total 33 particulates found (sizes in micrometer) - 129, 95, 89, 68, 58, 49, 45, 43, 40, 36, 34, 33, 32 (2), 30 (2), 28 (2), 26, 25 (2), 23, 21 (4), 18 (3), 16 (3), 15.
Hydrogen Fuel Index			99.996026%

Source: FirstElement Fuel, Inc.

Automaker Testing

Division of Measurement Standards Certification (3/2/2017)

The California Department of Food and Agriculture's Division of Measurement Standards is responsible for enforcement of California weights and measures laws and regulations and must certify any device used for metering the sale of commercial items within California.

Acting as a Registered Service Agent and working with the local County Weights and Measures Officer as a witness, FirstElement successfully put the dispenser into service as shown in Figure 9.

Figure 9: Division of Measurement Standards Certification Stickers at South Pasadena Hydrogen Station



Source: FirstElement Fuel, Inc.

Figure 10 shows the first retail customer using the South Pasadena Hydrogen Station.

Customer Usage (3/1/2017 – Present)

The first public customer filled their Hyundai Tucson at the South Pasadena station on March 1, 2017 and the station has been used regularly since then. The South Pasadena station sold 365 kilograms of hydrogen in March 2017 and 482 in April 2017.

Figure 10: First Customer Using the South Pasadena Hydrogen Station on March 1, 2017



Source: FirstElement Fuel, Inc.

Station Operational Status System Activated (4/10/2017)

Figure 11: California Fuel Cell Partnership Station Online Status System Showing South Pasadena Hydrogen Station Status



Station Status

Retail Stations	H70	H35	
Anaheim	●		
Campbell	●	●	TRUE ZERO
Costa Mesa	●	●	TRUE ZERO
Del Mar	●	●	TRUE ZERO
Diamond Bar	●	●	
Fairfax-LA	●	●	
Harris Ranch	●	●	TRUE ZERO
Hayward	●	●	TRUE ZERO
Hollywood	●	●	TRUE ZERO
La Canada Flintridge	●	●	TRUE ZERO
Lake Forest	●	●	TRUE ZERO
Lake Tahoe-Truckee	●	●	TRUE ZERO
Long Beach	●	●	TRUE ZERO
Mill Valley	●	●	TRUE ZERO
Playa Del Rey	●	●	TRUE ZERO
 Riverside (New)	●	■	
San Jose	●	●	TRUE ZERO
San Juan Capistrano	●	●	
Santa Barbara	●	●	TRUE ZERO
Santa Monica	●	●	
 Saratoga	●	●	TRUE ZERO
 South Pasadena (New)	●	●	TRUE ZERO
South San Francisco	●	●	TRUE ZERO
 UC Irvine	■	■	
West LA	●	●	
West Sacramento	●	●	
 Woodland Hills	●	●	

Source: FirstElement Fuel, Inc.

Figure 12 shows the South Pasadena Hydrogen Station open and fully operational.

Figure 12: South Pasadena Hydrogen Station



Source: FirstElement Fuel, Inc.

Environmental Impacts

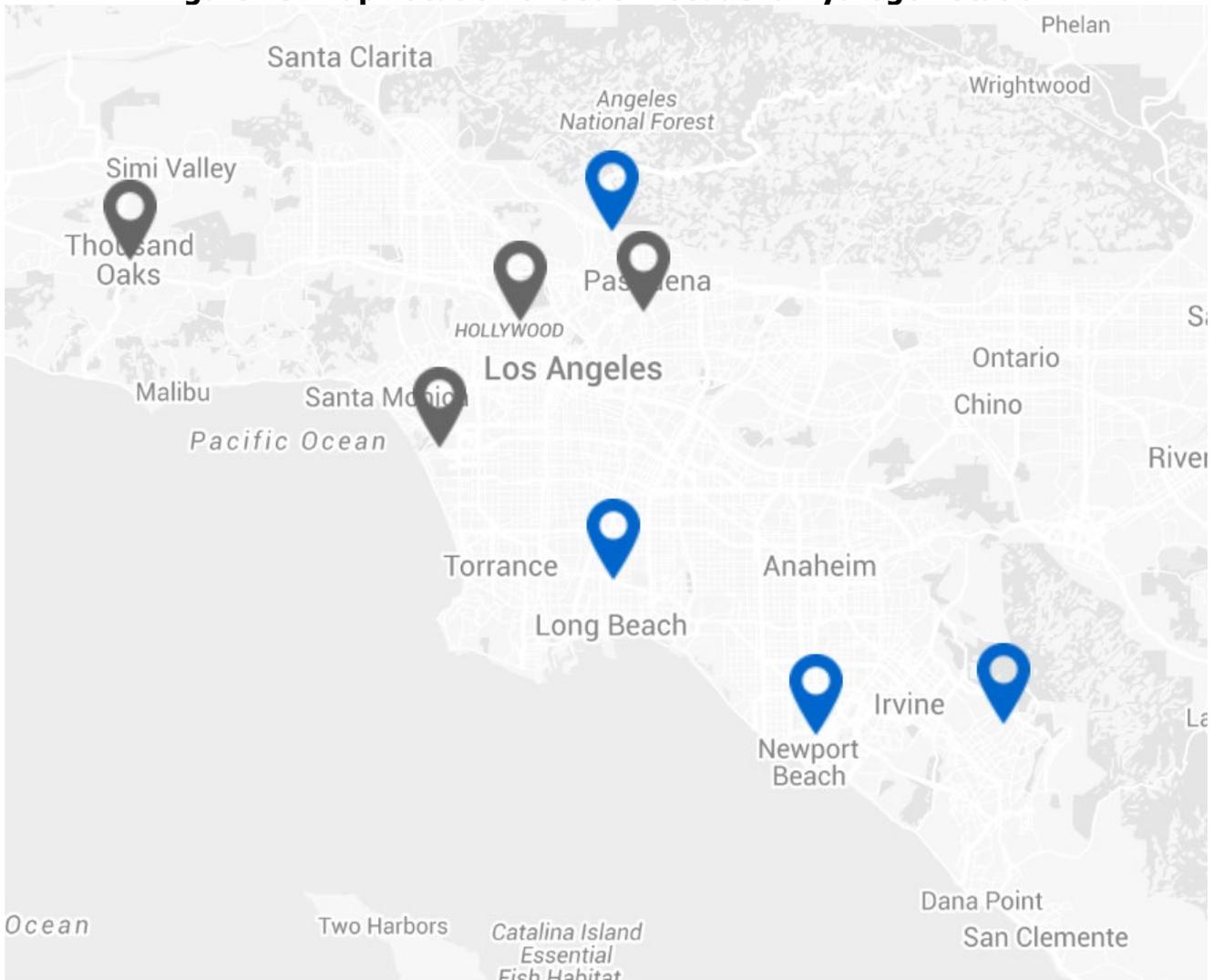
Minimal water was consumed for this project. However, additional landscaping was added for the construction of the hydrogen refueling station per city requirements that will require additional irrigation water.

The use will not cause any unsightly appearances, such as noise, glare, dust, or odor. The facility is a modern addition to an existing gasoline station. No outdoor sound amplification systems were installed; however, lighting was installed at the facility to aid in evening fueling.

South Pasadena Station in the Network

Figure 13 shows the location of the South Pasadena hydrogen station at 1200 Fair Oaks., South Pasadena as a primary station in the southern California area.

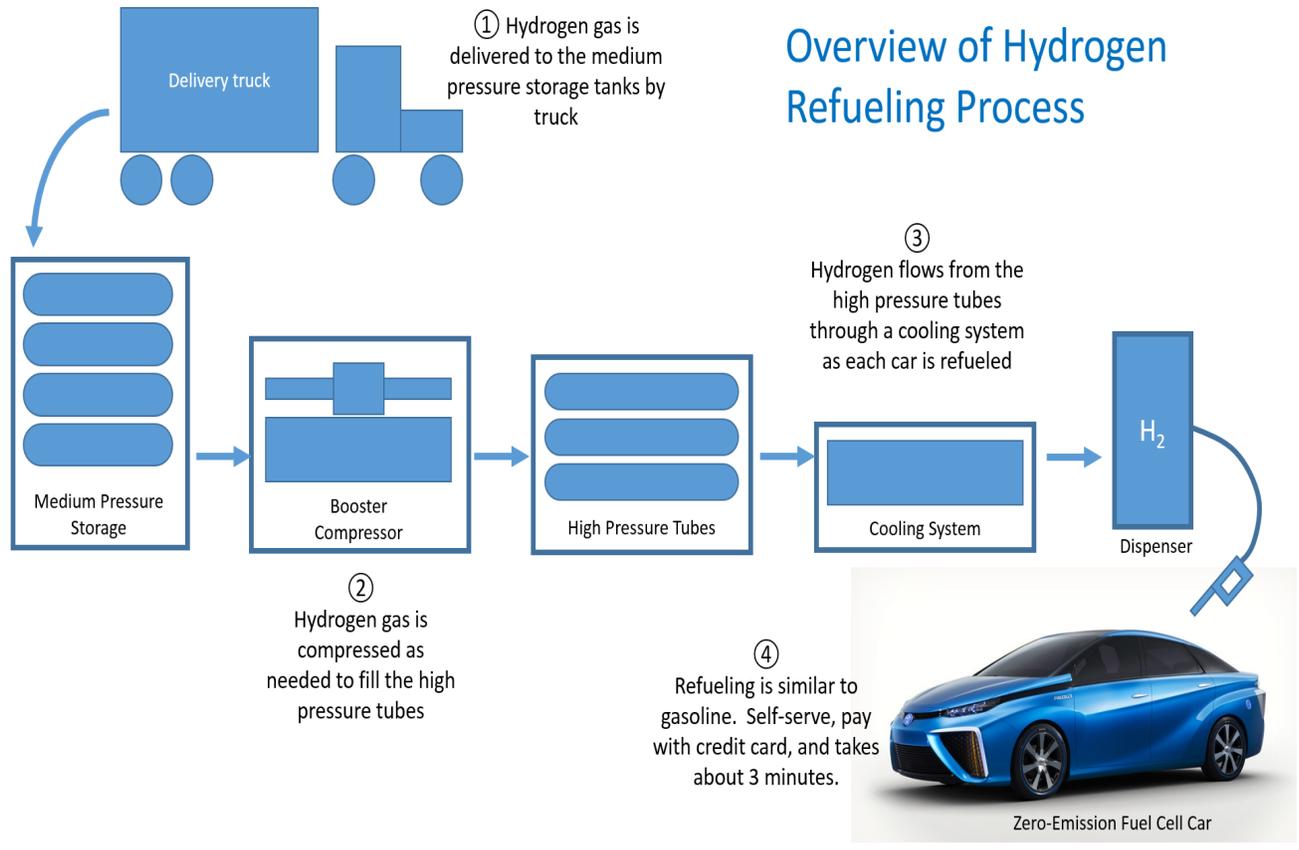
Figure 13: Map Location of South Pasadena Hydrogen Station



Source: FirstElement Fuel, Inc.

Schematic Layout of the South Pasadena Station

Figure 14: Schematic Depicting Hydrogen Station Equipment and Refueling Process



Source: FirstElement Fuel, Inc.

Figure 15 shows a detailed view of the actual final, as-built configuration of the South Pasadena station. Table 1 shows a list of subcontractors and budget for the project.

Table 1: List of Subcontractors and Budget

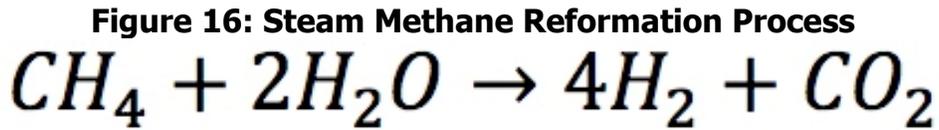
Air Products and Chemicals, Inc., Allentown , PA	
H2 station equipment	\$1,483,691.18
Black & Veatch, Overland Park, KS	
Construction	\$634,030.95
Engineering	\$78,682.99
Permitting	\$65,892.76
Project Management	\$20,910.62
Various Vendors	
Construction Materials (tubing, wire, etc.)	\$24,713.35
Fixtures (doors, lights, etc.)	\$60,331.40
MSI Tech, Irvine CA	
Data Collection Tool	\$2,353.56
Karen Calhoun, Newport Beach, CA	
Legal services	\$13,150.03
Vertical Advisors LLP, Newport Beach, CA	
Financial services	\$4,345.13
Total Vendor Costs	\$2,388,101.97
California Energy Commission Grant	\$1,451,000.00
Remaining cash provided by FE	\$937,101.97
Total CEC cost share (w/o FE internal costs)	60.8%

Source: FirstElement Fuel, Inc.

CHAPTER 2:

Data Collection and Energy Analysis

The South Pasadena hydrogen refueling station is supplied by hydrogen generated via the Steam Methane Reformation process, shown in Figure 16, that converts methane and water to hydrogen and carbon dioxide:



Source: FirstElement Fuel, Inc.

Per California Senate Bill 1505, Environmental Standards for Hydrogen Production, at least one third of the hydrogen sold by FirstElement’s state funded hydrogen refueling stations will be produced from renewable sources. Hydrogen is supplied to the hydrogen fueling stations from Air Products’ hydrogen production facilities in Wilmington/Carson, CA. Renewable biogas will be procured as feedstock for the facilities, resulting in delivered hydrogen product that meets the requirements of this program opportunity notice and the 33.3 percent renewable hydrogen requirements of California SB 1505 (sources of biogas shown in Figure 17). Renewable hydrogen at 100 percent is achievable through the same supply pathway, however at a higher cost.

Air Products currently has a contract for sourcing of the renewable biogas that meets Public Resources Code Section 2574(b)(1); documentation is provided in Figure 18. Although California has a substantial amount of biogas resources, local supply cannot be injected into California pipelines because of CA Health & Safety Code Section 25420. Air Products’ biogas supply for this project is being sourced outside of California and transported to California with connection to a natural gas pipeline in the Western Electricity Coordinating Council region that delivers gas into California.

Figure 17: Biogas Sources

Exhibit A
RB Supply Sources
Shell Energy North America (US), L.P.

Supply Source	Address	Pipeline/LDC	Receipt	Delivery
Greentree Landfill	635 Toby Road Kersey, PA 15846	National Fuels Gas	Landfill meter	Bristoria
		TETCO	Net Fuel-Bristoria	NGPL-Sweet Lake
		NGPL	Tetco-Sweet Lake 3825	EPNG Jnl 3083
		EPNG	EPNG Jnl 3083	Topock
		Socal Gas FAR	Topock	Socal Citygate
Imperial Landfill	11 Boggs Road Imperial, PA 15126	National Fuels Gas	Landfill meter	Bristoria
		TETCO	Net Fuel-Bristoria	NGPL-Sweet Lake
		NGPL	Tetco-Sweet Lake 3825	EPNG Jnl 3083
		EPNG	EPNG Jnl 3083	Topock
		Socal Gas FAR	Topock	Socal Citygate

Source: FirstElement Fuel, Inc.

Figure 18: Biogas Supply Contract Between Air Products and Chemicals, Inc. and Shell Energy North America

**SELF-GENERATION INCENTIVE PROGRAM
DIRECTED BIOGAS FUEL SUPPLIER
ATTESTATION**

I, Shell Energy North America (US), L.P., hereby attest that Directed Biogas will be supplied to Air Products and Chemicals, Inc. by nomination and will comply with all applicable rules of the Self-Generation Incentive Program (SGIP) including but not limited to;

- a) Contract will include term (minimum of 5 years), cost, amount of renewable fuel injected on a monthly basis for the length of the contract, address of renewable fuel facility, and facility address of Host Customer.
- b) Documentation will be provided that shows that the third party gas provider can inject the renewable fuel into the natural gas pipeline.
- c) The Renewable Fuel Supplier facility must produce fuel that meets the SGIP definition of renewable fuels.
- d) The gas must be injected into a natural gas pipeline system that is either within the Western Electricity Coordinating Council (WECC) region or interconnected to a natural gas pipeline in the WECC region that delivers gas into California.

The undersigned understands that non-compliance to any SGIP requirements will be grounds for partial or complete incentive refund.

Shell Energy North America (US), L.P.

Signature: 

Name Printed: Edward Brown

Title: Vice President

Company: Shell Energy North America (US), L.P.

Date: 3/21/2011

Source: FirstElement Fuel, Inc.

Hydrogen is delivered to all FE stations (including South Pasadena) by a Department of Transportation certified high-pressure delivery trailer.

The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model produced by Argonne National Laboratory was used to determine the energy sources and greenhouse gas emissions data presented in Table 2. As shown, 1/3 of the energy feedstock is renewable, nearly zero petroleum is used, and the only tailpipe emissions are water compared to the myriad pollutants emitted by combustion of gasoline. Also, the entire well-to-wheels greenhouse gas emissions are 58 percent lower than similar usage for a typical California gasoline vehicle.

Table 2: Percentage of Energy Sources and Well-to-Wheel Greenhouse Gas Emissions for FirstElement Hydrogen Compared to Average California Gasoline

Energy Sources	Fuel Cell Vehicle fueled at FirstElement station	Average California internal combustion car fueled by gasoline
Coal	1.7%	0.4%
Petroleum	0.3%	78.6%
Natural Gas	64.7%	13.9%
Renewable	33.3%	7.1%
Total Greenhouse Gases	178 grams/mile	428 grams/mile
Tailpipe Emissions	Pure Water	VOC, CO, NOx, PM10, PM2.5, SOx, CH4, N2O, and toxins

Source: FirstElement Fuel, Inc.

The South Pasadena hydrogen station is capable of dispensing 180 kilograms/day. Assuming that fuel cell electric vehicles average 52 mile/kilogram (taken from the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model), and consumption of 180 kilograms/day for the next 10 years, the station will offset 8,384 metric tons of total greenhouse gases compared to equivalent gasoline vehicles. Also, the South Pasadena hydrogen station will eliminate over 1.54 million gallons of gasoline, assuming the 2013 national passenger fleet average fuel economy of 21.6 miles per gallon¹.

Data on the operation of the station will be collected and reported to the CEC throughout the term of an associated operations and maintenance grant through the Clean Transportation Program. Data collected and reported will include throughput, vehicle usage, gallons of gasoline displaced, and a comparison of the project’s actual performance to proposed expectations.

1 Department of Transportation, Bureau of Transportation Statistics; [Table 4-23: Average Fuel Efficiency of U.S. Light Duty Vehicles](http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html); available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html

CHAPTER 3:

Statement of Future Intent

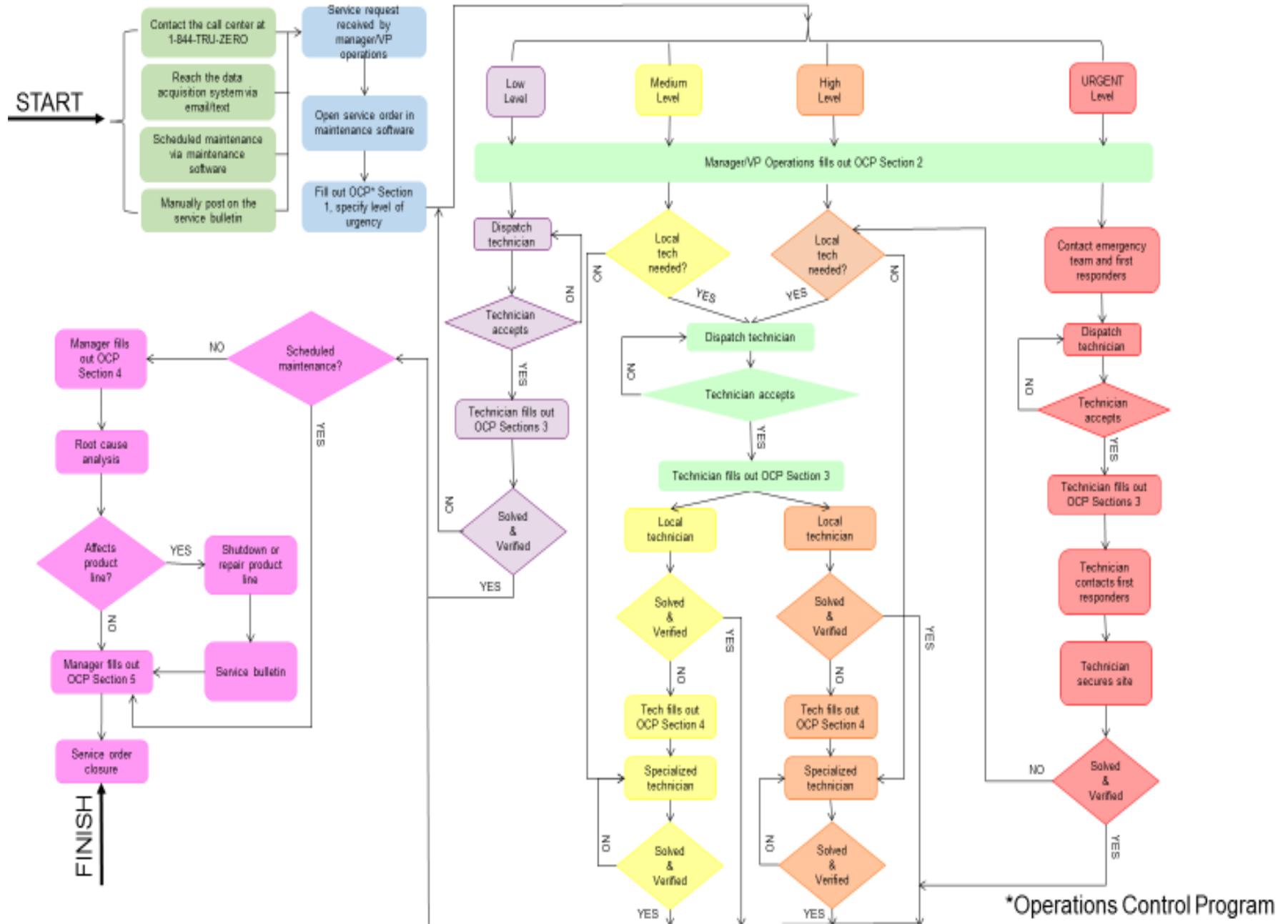
FE intends to own and operate the refueling station at 1200 Fair Oaks Avenue, South Pasadena, CA for at least 10 years. FE has invested substantial capital to build the station and will require many years of operation to recoup the development costs. FE has executed an initial 10-year lease with the landowner with the possibility for extension.

In addition, FE is building an in-house maintenance team that will have the personnel and equipment resources to maintain and repair any of our stations as quickly as possible throughout California. Figure 19 shows a flow diagram for response from the Operations and Maintenance team.

To augment onsite personnel across the FE network, a comprehensive data collection and monitoring system has been implemented. Figure 20 shows a screenshot of one page of the system. FE maintenance personal can access a breadth of real-time performance and sensor data, live video feeds, and historic usage data, and can control some features of the station remotely, 24 hours a day.

In addition to remote monitoring, FE has implemented rigorous Computerized Maintenance Management Systems and Enterprise Asset Management systems to schedule and track maintenance, repairs, and inventory. Work orders will be generated, completed, and logged for all maintenance and repair activities. This will help to maximize station up-time and enable tracking of key performance indicators.

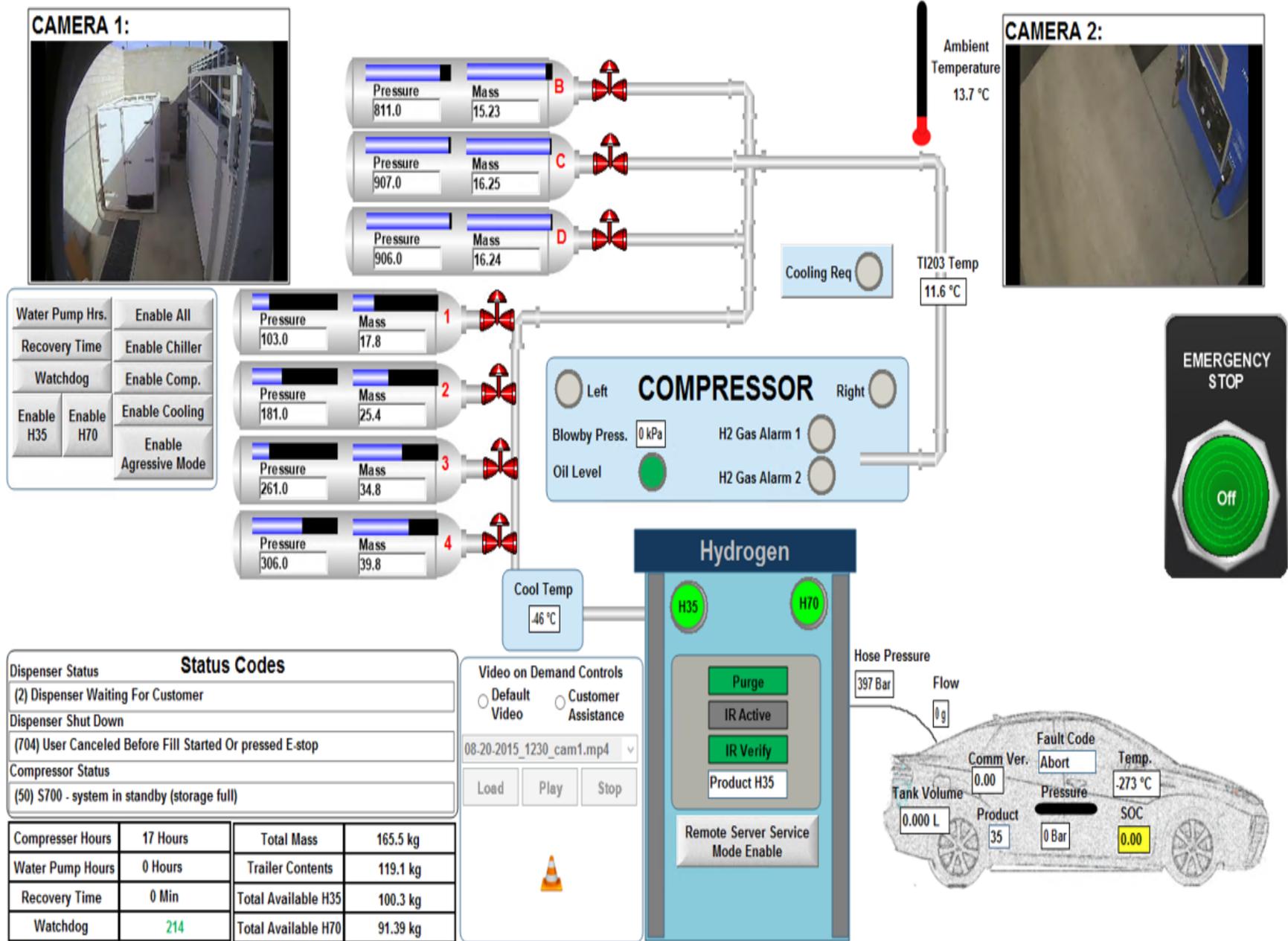
Figure 19: FirstElement Operations and Maintenance Control Plan



*Operations Control Program

Source: FirstElement Fuel, Inc.

Figure 20: FirstElement's Remote Monitoring System



Source: FirstElement Fuel, Inc

CHAPTER 4:

Findings, Conclusions, and Recommendations

The following is a list of important findings from the South Pasadena hydrogen station project:

- The South Pasadena hydrogen station is located in a picturesque bedroom community. Not surprisingly, many of the neighbors who live adjacent to the existing gasoline station would prefer for it to be removed and redeveloped. FirstElement's hydrogen station project provided an opportunity for jaded neighbors to publicly resist the hydrogen project and the existing gasoline station.
- Because of community backlash against the gasoline station, three public zoning commission hearings were required before project approval was obtained. Then, following the protocol of South Pasadena, the dissatisfied neighbors petitioned the City Council. The hydrogen station project finally gained unassailable approval at a City Council hearing.
- National Fire Protection Agency 2: Hydrogen Technologies Code is a critical tool for working with permit agencies. The code clearly defines fire safety guidelines that enable local jurisdictions and builders to reach common ground, while also ensuring safety via the rigorous National Fire Protection Agency code writing process. The key is for both station builders and station permit agencies to fully understand, and appreciate, the content of National Fire Protection Agency 2.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

Construction Drawing (CD)—Construction drawings form part of the overall documentation that is used for tender, for the contract between the employer and contractor, and for the construction itself. The construction drawing provides a graphic representation of how the building will be built.²

FirstElement Fuel, Inc. (FE)— A California-based company established in 2013 to provide safe, reliable, retail hydrogen to customers of fuel cell electric vehicles. The company is the developer, owner and operator of the True Zero brand of retail hydrogen stations, which currently represents the largest retail hydrogen station network in the world.

² [What is a Construction Drawing](https://www.firstinarchitecture.co.uk/what-is-a-construction-drawing/) is available at <https://www.firstinarchitecture.co.uk/what-is-a-construction-drawing/>